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METHOD FOR THE INDICATION MEASUREMENT OF MICROSTRUCTURES (NOSEARC FORMATION) ON MECHANICALLY ROUGHENED CYLINDER TRACKS

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METHOD FOR THE INDICATION MEASUREMENT OF MICROSTRUCTURES (NOSE/ARC FORMATION) ON MECHANICALLY ROUGHENED CYLINDER TRACKS

Technical task:
The invention examines nose or bow formation during the mechanical roughening of coating material.

Initial situation:
Today's cylinder liners may require a coated surface in order to be compatible with the piston ring/cylinder bore piston to form a functioning robust tribosystem. APS (Atmospheric Plasma Spray) coating is often used for this purpose. To enable the coating material to bond with the base material (here aluminium), the surface to be coated must be activated, i.e. roughened. There are several possibilities for this. In series production, mechanical roughening is used to create undercuts, Figure 1 and 2. Noses or arches (also known as crests or mushroom heads) can be created during mechanical roughening. These noses or arcs in turn can be starting points for layer defects, i.e. if the nose or arc becomes too large, this leads to a niO (not okay) component. Furthermore, the formation of a nose or arc is the criterion for a necessary, imminent tool change. Today, these noses or arcs are measured laboriously either by means of micrographs (destructive testing) or by means of separately prepared impression material under the light microscope, Figures 2 and 3.

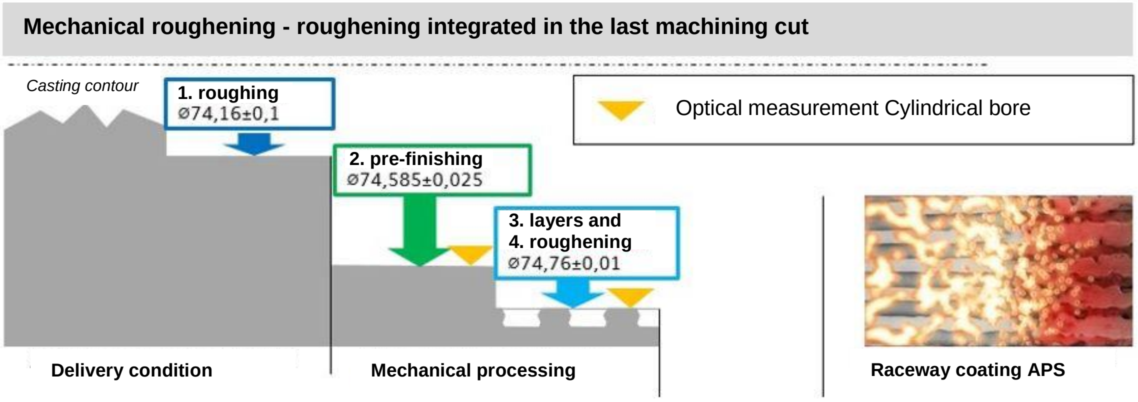

Figure 1: Process sequence from raw contour to APS coating

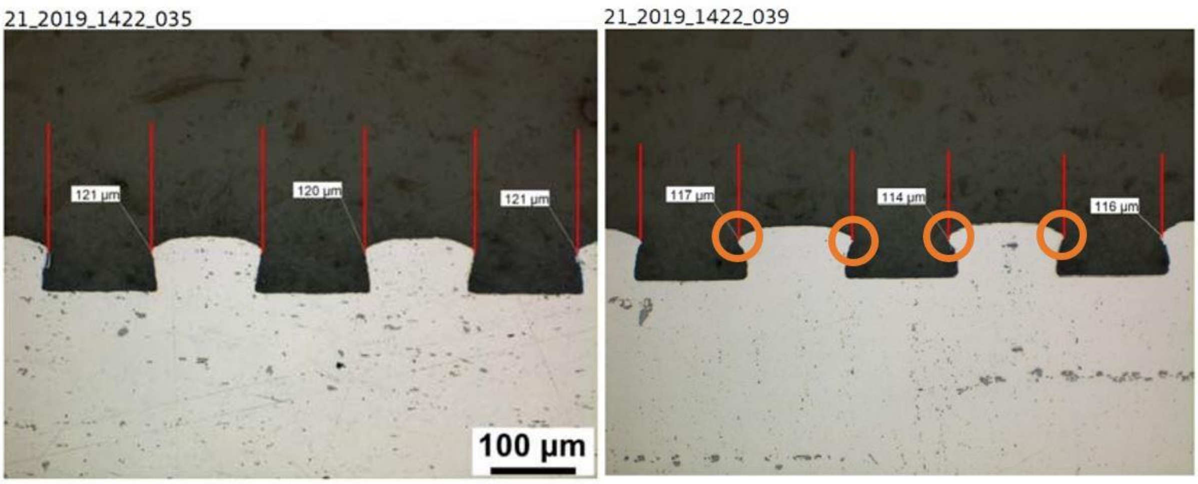

Figure 2: Microsection of a mechanically roughened surface (without APS layer), left: iO, right: niO, orange circles = nose or arch

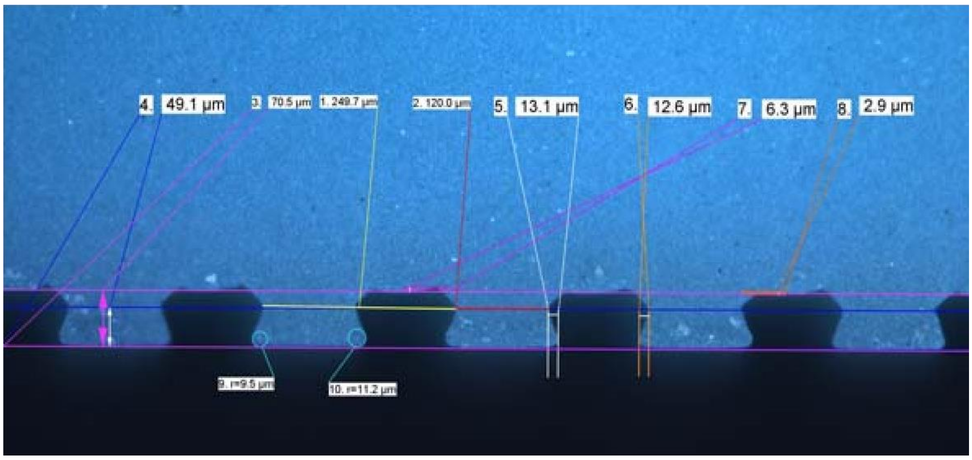

Figure 3: Example of microscopic profile measurement of an impression from a mechanical roughening (black = air)

In order to guarantee process reliability and roughening quality, a downstream inspection of the nose or bow formation is essential. In most cases, statistical methods are used in mechanical manufacturing to check components (e.g. checking every 50th component). For this reason, one receives feedback on the component quality of the production lot only at a very late stage. Often production is stopped until the measurement results are available. Downstream inspection processes therefore always lead to losses in value added (e.g. through reworking, rejects, resource commitment, ...).

The already examined patent or the disclosure/application document EP18205612 does not fulfill the claim of the present invention.

Solution:
The aim is a clocked 100% inspection for nose or bow formation shortly after the manufacturing process.
The nose or bow formation cannot be measured directly with the procured measuring technology. However, the sensors used enable an "indication measurement" with which the nose or bow formation or the tool condition can be concluded. The core idea is that with a "nose-free" surface, the light is reflected directly back into the lens (or sensor). However, as the nose/arc becomes more and more pronounced, an increasing amount of light is not reflected back into the lens (or sensor), see Figure 4. This effect can be used by statistical methods to check the surface condition.

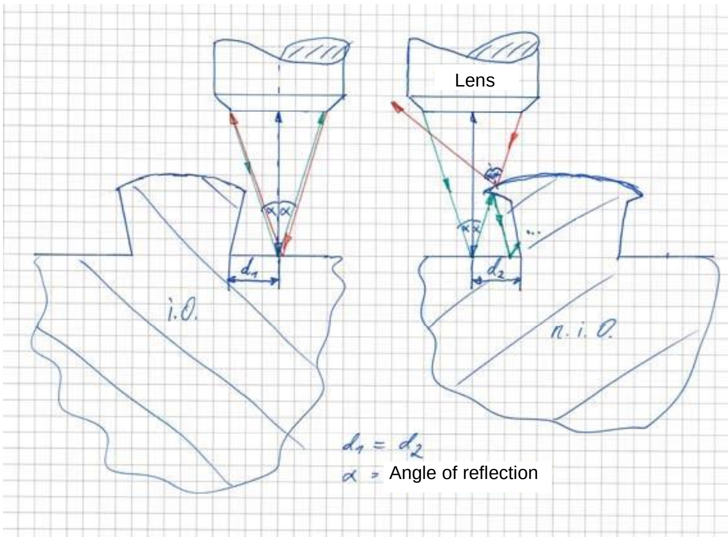

Figure 4: Sketch of the physical effect used (not to scale!)

Advantages:
A clocked 100% measurement of the nose or bow formation shortly after the manufacturing process enables early intervention and increased process reliability, which reduces scrap and costs. Furthermore, the downstream, costly component testing (conformity) can be reduced to a minimum.

Possible application:
Chromatic confocal point sensors are used to measure sheet formation. In addition to the partial profile (without undercut), the noses or arches can be determined indicatively in this way. The statistical evaluation of the so-called reflectivity or invalidity rate, which makes the physical effect from figure 4 measurable, results in clearly assignable value progressions (green in figure 5), for new or heavily worn tool cutting edges or small and large noses or arcs, see figure 5. Even in the profile progression (grey in figure 5), one can recognize rudimentary artifacts caused by the optically uncooperative surface (nose formation).

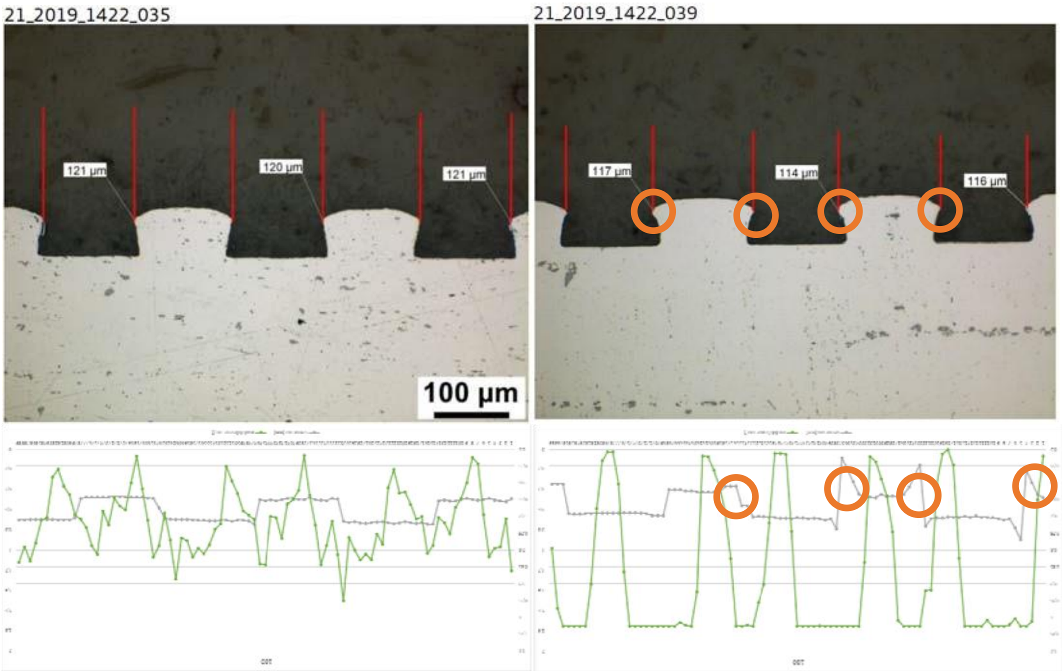

Figure 5: Microsections (top) and measurement results (grey = profile, green = invalidity rate or reflectivity) of mechanically roughened surfaces (left iO, right niO)